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ABSTRACT

The Digital Steppingstones (DSS) project is a 3-year study exploring access to advanced information technologies and related training in low-income and minority communities. The project is also identifying exemplary information technology programs in schools, libraries, and community centers in disadvantaged areas of five large cities. Site visits, roundtable discussions, and interviews determined characteristics of exceptional programs and barriers to access to advanced telecommunications that exist in underserved communities. First-year findings identified five characteristics of exceptional programs: extensive staff training; creative funding and budgeting; leadership that values the use of technology in education and demonstrates entrepreneurial drive in developing programs; community involvement in planning and decision making, as well as participation in the program itself; and collaboration and information sharing. Barriers to effective program implementation include difficulties in maintaining dependable funding streams; providing on-going, comprehensive staff training; maintaining consistent leadership; promoting information sharing; and keeping up with rapid technological innovation. Also, questions concerning the efficacy of technology in the classroom challenge decision-makers at all levels. Recommendations for program development are offered. (Contains 21 references.) (TD)

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Latino Studies Series

Minority Access to Information Technology: Lessons Learned

by Harry P. Pachon, Elsa E. Macias, and Paula Y. Bagasao
Tomás Rivera Policy Institute

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October 2000

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Abstract
This paper was presented at the conference "Latinos, the Internet, and the Telecommunications Revolution," sponsored by The Julian Samora Research Institute, in conjunction with the College of Social Science at Michigan State University, Tuesday, April 27, 1999.

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The **Julian Samora Research Institute** is committed to the generation, transmission, and application of knowledge to serve the needs of Latino communities in the Midwest. To this end, it has organized a number of publication initiatives to facilitate the timely dissemination of current research and information relevant to Latinos.

- *Research Reports:* **JSRI**'s flagship publications for scholars who want a quality publication with more detail than usually allowed in mainstream journals. These are produced in-house. Research Reports are selected for their significant contribution to the knowledge base of Latinos.

- *Working Papers:* for scholars who want to share their preliminary findings and obtain feedback from others in Latino studies.

- *Statistical Briefs/CIFRAS:* for the Institute's dissemination of "facts and figures" on Latino issues and conditions. Also designed to address policy questions and to highlight important topics.

- *Occasional Papers:* for the dissemination of speeches, papers, and practices of value to the Latino community which are not necessarily based on a research project. Examples include historical accounts of people or events, "oral histories," motivational talks, poetry, speeches, technical reports, and related presentations.

Minority Access to Information Technology: Lessons Learned

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Minority Access to Information Technology: Lessons Learned

The Information Age is evolving so rapidly that what we mean by digital literacy is inherently difficult to define. Previously, schools, colleges, and employers concentrated on preparing students to become technically proficient computer users, which meant being able to program in various computer languages, develop and use electronic databases, and acquire spreadsheet and word processing skills. Today, digital literacy encompasses an expanded conception of the use and manipulation of information technologies to broaden our learning and communicating opportunities, including to learn basic competency skills such as reading, writing and math. Digital literacy is about using digital technology as a tool to learn "a new language of events, processes, and dynamic relationships that will help make the world and its ideas more understandable, more communicable, and more civilized" (Kay, 1997). As Gilster and Shea articulate, "being digitally literate is multidimensional and interactive," (1998). Terms that are particularly meaningful as advanced multimedia technologies and the Internet displace the importance and appeal of older technologies such as typewriters and even television. In turn, these new technologies are impacting our sense of who we are, how we define our cultural mores, and how we live (Negroponte, 1995; Turkle, 1995).

Exploring the challenge to our society to achieve digital literacy in minority and low-income communities is at the heart of the Tomás Rivera Policy Institute's (TRPI) research efforts on information technology. The Institute's Digital Steppingstones (DSS) project is bringing to light some valuable lessons about the gaps that exist in access to information technology and how together we can reduce this discrepancy. This paper presents pertinent access and equity issues in information technology, as well as barriers that are faced by minority and low-income communities and how they can be overcome.

Access and Preparation

It is now widely accepted that the approaching new century is developing as an information-based, global society in which digital literacy will be a prerequisite for full participation. Estimates about the viability of computer skills in the workplace suggest that those with computer skills already earn about 10% or slightly more than those who do not. The three fastest growing careers are in computer-related fields, and they offer higher-than-average earning potentials (U.S. Department of Labor, 1999). By the beginning of the next century, 60% of all new jobs will require computer skills. Therefore, anyone who does not have these skills will be at a competitive disadvantage for the best paying jobs. Based on this snapshot of our future needs, learning how to use advanced information technologies proficiently is an integral component of a comprehensive education for today's students.

With the increasing presence of advanced technologies in our society, addressing a gap between the information "haves" and "have nots" becomes a compelling mandate. Currently, Hispanic and Black youth are less likely to use a computer at school and less likely to have one at home, which means that they stand at a competitive disadvantage relative to their Anglo cohorts in accessing advanced technologies (NTIA, 1998). TRPI surveys indicate that one in three adult Latinos have never used a computer at all (TRPI, 1998). Access becomes an issue of social equity, since equal access to the technology and the skills to use it are increasingly necessary for economic success (Chapman, 1998). The implications of inequality of access to fundamental digital resources means nothing less than risking the exclusion of disadvantaged groups from economic, social, educative, and political life.

Given these findings, meeting the demand for a well-prepared workforce is problematic. A 1992 U.S. Department of Labor Report shows that a combination of proficiency in both technical skills and basic reading, writing, and math skills — the "3 R's" — is in demand among employers. In a 1997

report issued by the State of Michigan about a survey of 525 businesses, industries, and governmental agencies, respondents said that, above all else, they wanted employees with good attitudes and good oral and written communication skills. Other important factors were that potential employees be independent and quick learners, be multi-culturally aware, possess foreign language competency, and be computer literate. Knowledge of science and technology has become a necessity of modern life.

Providing equitable access to advanced technologies in underserved communities is one way to undertake fulfilling this demand (Benton Foundation, 1998). Many employers would like to see more computer literacy skills taught in K-12 schools to ensure prospective employees possess the skills the employers need. Doing so increases the productivity of the workforce while also curtailing the need to import foreign talent. Additionally, students will be more prepared and better motivated to enter universities to train as higher-level professionals in the fields of technology. Ultimately, this results in the ability of the United States to retain a competitive edge in the global market.

Scope of the Project

To determine how access to information technology is best achieved in the nation's low-income urban areas, TRPI launched the DSS initiative with funding from the W.K. Kellogg Foundation. The objective of this 3-year study is to explore the role of advanced technologies in low-income and minority communities, and determine their effectiveness in providing access to technology and training, preparing community members for the workforce, and filling communities' information needs. The DSS project is identifying exemplary information technology programs in schools, libraries and community centers, focusing on programs in five urban settings — Los Angeles, Chicago, Houston, Miami, and New York City. Schools, libraries, and community centers provide the most common points of access to advanced technologies in disadvantaged communities. Through this research, TRPI ultimately hopes to identify the barriers to access to advanced telecommunications that exist in underserved communities and give direction on how to remove those barriers.

To begin, TRPI identified several key research questions. *Where, how, and by whom are emerging digital technologies being used? Are they improving the quality of life for people living in disadvantaged communities? How do we ensure that all communities will have equal opportunities to benefit from these technologies?*

In Phase I of the project, TRPI conducted site visits and convened roundtable discussions in each of the five cities under study to begin exploring answers to these questions. An analysis of the wealth of insights participants shared allowed us to determine what characteristics of information technology programs are strong indicators of success, as well as identify unique solutions to common problems. This document reports on our progress during the first year of the project, focusing on findings during site visits, but also on roundtable discussions as they relate to exemplary program sites.

While the research we conducted has yielded much useful data, many questions remain unanswered and more questions have been raised. We will attempt to address these questions during Phase II of the project. A systematic selection of programs is being implemented, and this is augmented by a national nominations process begun in the roundtable discussions to provide additional outside validation of our selections for study.

Methods and Research Activities

Phase I

While site visits were originally scheduled to occur during Phase II, it was helpful to conduct preliminary site visits to identify appropriate roundtable discussion participants. Roundtable discussions were comprised of knowledgeable librarians, educators, and community members representing the diverse learning environments under study; program sites were identified through a "snowball" enumeration technique. We began with schools by investigating district system(s) in each city. General information, including student population, ethnic composition, and other statistics, was gathered through research on the Internet or from official district reports and documents. Telephone calls to individuals associated with instructional technology yielded suggestions for eligible

programs. We also relied on the recommendations of educators, librarians, and other informed individuals, as well as program websites. Community centers and libraries were also identified through web searches, telephone calls, and recommendations. Each city's main public library was the usual starting point, although branch libraries were sometimes identified as the best location for most effectively reaching minority and low-income communities.

We attempted to meet with the individual(s) most familiar with each program. Usually, this was the principal and/or technology coordinator at schools, the branch or division librarian, and the director and/or technology coordinator at community centers. Some interviews were with school district and county administrators or university professors who provided an overview of technology activities within the district or region, including collaborative efforts with universities. The interviews were semi-structured, revolving around the history of the program, funding and sustainability issues, decision-making procedures, technology penetration and dispersion, wiring, types of technology, and professional development. A guide provided a degree of standardization between the interviews and ensured that all pertinent areas were covered. Whenever possible, site visits were planned when users were present to obtain a sense of their working environment.

This report is a preliminary appraisal of potentially exemplary programs, and inclusion or omission of any given program is not necessarily an indication of its standing as an exemplary information technology program. We are aware of several promising programs we have not visited due to time and logistical constraints. As we enter the main data collection phase of our research, we begin a concerted, directed effort to investigate more of these programs.

A chief concern in identifying exemplary information technology programs was that they be replicable. Research focused on disadvantaged communities with limited resources, making funding and sustainability issues for high-priced technology programs particularly significant. While some features of exemplary programs were clearly identifiable and relatively simple to delineate, others such as exceptional entrepreneurial skills, were susceptible to subjective assessment and could prove difficult to replicate. Yet several patterns are sufficiently common in schools, libraries, and community centers in underserved communities as to merit our attention. These characteristics are described and explained below to facilitate their emulation as much as possible.

Findings

TRPI's findings are based on information gathered at roundtable discussions and site visits conducted in five select cities. Although the site visits represent preliminary data collection efforts, several themes that characterize exceptional programs became evident. These preliminary indicators of success included: **(1)** extensive staff training to maximize use of technology in educational curricula and for information-seeking strategies; **(2)** creative funding and budgeting, including reallocation of existing budgets and attracting alternative funding sources such as public and private partnerships and grants, to ensure the program can be sustained while enhancing its innovation; **(3)** leadership that values the use of technology in education and demonstrates entrepreneurial drive to develop an information technology program; and **(4)** community buy-in to provide impetus and support for technology through their involvement in planning and decision-making, as well as through their active participation in the program itself; **(5)** furthermore, collaboration and information-sharing have been identified as effective means of achieving these indicators in communities with limited resources and experience.

In this paper we also discusses some key barriers to effective implementation of IT-related programs. Perhaps the most obvious problem for information technology programs is the need to maintain dependable funding streams in order to develop and sustain programs and maintain current technologies. It is also difficult to provide the necessary on-going and comprehensive staff training. But other obstacles are perhaps not so apparent. Difficulties in maintaining consistent leadership and promoting information sharing are two such issues these programs face.

Furthermore, questions about the efficacy of technology in the classroom continue to challenge decision-makers at all funding levels. The following discussion presents a few programs found to be exemplary along one or more indicators identified above. Each surmounted some or many of numerous, and sometimes formidable, barriers to successful implementation with ingenuity, innovation, and resourcefulness. We hope these solutions can be generally applied in other disadvantaged communities.

Programmatic Variation

Programs vary greatly from site to site. One variation is in how computers are distributed within each site. When programs are small or growing with limited resources, information technology equipment tends to be situated in a computer laboratory. The advantage of computer labs is that they are a cost-effective way of allocating limited resources. Computer labs grant access to the greatest number of people and, when networked, allow multiple students to work simultaneously while being easily supervised by one teacher. But locating all the technology in labs hampers efforts to integrate technology across the curricula since students do not have ready access to it throughout the day. Many schools have plans for networked computers in classrooms when funds permit or wiring problems are overcome.

By contrast, larger, more developed programs generally have one or more computer labs, as well as computers located in classrooms for student use. A goal of four to eight networked computers per classroom is the norm, with some sites approaching that goal and a few, most notably Foshay Learning Center in Los Angeles, Cutler Ridge Middle School in Miami, and Northbrook Middle School in Houston, meeting or exceeding it. Placing computers in classrooms and allowing students easy access to them facilitates project-based learning, encourages critical thinking skills, and teaches group cooperation that simulates real-world workplace situations. While full penetration, with one computer per student, may make this easier to achieve, funding constraints make this goal infeasible at this time.

Institutional Variation

Differences between schools, libraries, and community centers are generally related to differences in their missions. Community centers generally have one or two computer labs where students work in classes or independently. Information technology programs at these centers tend to focus on individual activities, such as adult education and employment skills, and the move toward dispersing computers is not as compelling as it is in schools. An advantage for working-class parents is that community centers may also provide child and health care services, as the Erie Neighborhood House in Chicago does. Combining access to technology with other community services increases the opportunity for community members to participate in the information age.

City libraries are deeply involved in developing digital literacy among its patrons. Libraries focus on expanding the already substantial skills employed by librarians to access sophisticated on-line resources to make them readily available to all. The libraries we visited tended to have few classroom or lab settings, but, instead, provided many free-standing, networked computer terminals. However, the Los Angeles Public Library's Young Adult Services Department provides a separate lab-type setting where students without computer or Internet access at home can complete homework assignments or explore telecommunications technologies for recreation in a supportive environment. Computer literacy is a priority, especially for the disadvantaged, based on a finding that circulation has increased as interest in information technology has escalated. The Brooklyn Public Library supports an Education, Job, and Computer Center (EJCC) with 12 networked, Internet-connected computers. The EJCC provides word processing and desktop publishing in addition to education and job services. This library caters to patrons in a multi-lingual lab, offering language acquisition and reading software in 17 languages and books and other materials in 38 languages.

The following section describes five "exemplary program characteristics" which TRPI feels serve as preliminary indicators of success. As the DSS Phase II research proceeds, this list of indicators will be validated, and refined.

Exemplary Program Characteristics

Integration of Technology

Computers are increasingly regarded as learning tools, rather than as a panacea for educational concerns. Most schools appear to be moving away from computer classes that stress a didactic "drill-and-practice" approach to learning. There is a growing trend highlighting project-based learning techniques that integrate information technology into the curriculum. Computers are used as tools to accomplish diverse learning goals, as opposed to the once-common approach to teaching students computer languages, word processing, and programming, as separate subjects (Dockstader, 1999). Integrating digital technologies into the subject matter content across curricula is key to its success in education. Furthermore, these activities frequently occur in individual classrooms as more technology is deployed and this facilitates their integration with learning endeavors (Becker, 1994).

Advanced telecommunications provide unprecedented access to a wealth of information. However, this in itself presents further pitfalls for consumers of information. Internet content remains relatively unregulated. For example, verifying the accuracy and timeliness of information remains essentially the responsibility of the user. Digitally literate consumers must be able to assess the validity of information, understand how amassing information is different from knowledge, and know which is the best tool for their needs (Brouwer, 1997).

In order to have competent students, we must first have teachers who are capable of teaching the skills needed for success. Professional development of teachers is a weak link in delivering effective support for students to fully exploit the resources that computers and technology make available. Although many teaching programs now offer courses on integrating and using technology within the context of the curriculum, there continues to be a large gap in uniformity in the schools. Student teacher training at universities must include training in integrating technology into curricula, a trend that appears to be prevailing, but not mandatory in many states. Librarians are the most digitally literate staff group in our study since their educational training specifically prepares them to understand and manipulate information systems and how to apply them.

Providing adequately trained teachers and staff in schools and community centers is also a challenge. Getting staff to commit, or "buy in" to technology as an integral component of education is key. Teachers must be convinced of its value in order to be willingly retrained, effectively use the technology, and integrate it into their curriculum. However, this change requires a shift in pedagogy that is difficult to define, much less implement. These endeavors require time commitments from teachers and financial support from academic institutions, neither of which may be forthcoming. Many programs have, at best, informal professional development programs with limited funding. Some exemplary programs, Hogg Middle School in Houston, for example, have extensive in-house training with technical expertise readily available.

Teachers, especially older ones, can be resistant to the change the introduction of new technologies commands (Albaugh, 1997). The National Science Foundation is one of many institutions that continually examines different mechanisms for expanding the knowledge base of established teachers to improve their instructional skills. Several studies point to the necessity of training teachers to ensure that computers are effective tools in the classroom (Dockstader, 1999; Technology Counts, 1998). In fact, roundtable participants in most cities cited staff and professional development as crucial to the success of integrating technology into the curriculum. While teaching is changing to enable students to exploit the power of technology, teachers must also emphasize critical thinking skills to enable students to evaluate the validity of information they access and manipulate.

Creative Funding

The single most pressing issue for all program sites we visited, regardless of location or type of program, was the cost of gaining and retaining access to advanced technologies. This was true not only in terms of acquiring the equipment and training needed to establish a working program, but also in sustaining the program long term. Information technology's inherently rapid obsolescence amplifies this problem, since computers must be replaced every three to five years to remain current. Indeed, many schools cut the cost of maintaining their systems by training teachers and coordinators to fix them. Some schools, such as Cage Elementary School of Houston and Los

Angeles' Manual Arts High School "recycle" older computers into the lower grades to teach word processing skills while retaining the newer, faster computers for upper classmen to use in project-based learning. Cutler Ridge Middle School takes another approach, extending the useful life of their computers by using "upgradeable" technology for components like central processors and outdated motherboards.

The New Technology High School accepts the economic burden and even takes pride in setting the standard for technology in its community, and faces high expectations to maintain its cutting-edge status. Foshay Learning Center makes only the newest computers available to its students, a commitment that carries a higher sustainability cost. Many well-equipped program sites are in the process of installing ISDN or T-1 lines, and upgrading their computer equipment to include multimedia capabilities. Similar programs may be prohibitively expensive to replicate in many low-income institutions. The pressure to maintain relevant technologies is an unavoidable reality in this rapidly evolving field.

Bringing a building's infrastructure up to current standards is another costly, but necessary, undertaking to fully implement a comprehensive information technology program that includes extensive computer access, and networked, multimedia capabilities. Some program sites face the challenge of wiring exceptionally old buildings. This is particularly difficult in the oldest building sites, which can be over 100 years old, and where electrical outlets are insufficient for the demand. Indeed, even the resources necessary to rewire a 20-year-old building are problematic for some already strained school budgets. Several principals pointed out the difficulty in convincing stakeholders to invest enormous amounts of money into projects like wiring that is mostly unseen.

Cage Elementary School in Houston, implemented a sophisticated program with no outside financial resources through the authority of a unique coalition. The principal, together with a "shared decision-making committee" of teachers and parents, creatively reallocated the existing school budget to procure current telecommunication equipment and software. Parents were hired part-time to perform duties usually performed by instructional aides. The remaining full-time instructional aides were then used more efficiently, and funds saved were applied to technology needs. While it is quite remarkable that this program has been developed without outside funding, the principal admits he would like to be able to take advantage of grants.

An entrepreneurial approach to fundraising is often the catalyst to mobilize the resources needed to establish and sustain an information technology program. Most learning centers in disadvantaged communities have heavy financial constraints that limit spending on high cost digital technologies. In Los Angeles, and to a lesser extent in Houston school districts, funding alone was insufficient to set up and run advanced telecommunications instructional programs. Therefore, fostering industry and business relationships to boost limited financial budgets proved to be the common solution among successful programs. This approach, however, requires a grasp of business principles for which some individuals heading learning centers may not be prepared. Nevertheless, almost all the most successful programs we visited fostered these valuable partnerships with the private sector.

Grants are also a crucial funding source. These may include city, state, and federal grants, plus the E-rate, as well as private grants. Yet it was evident that many programs in disadvantaged settings fail to exploit these potential resources. Primary reasons include inexperience with writing grant proposals, lack of awareness that sources exist, lack of time to find promising grant programs, and inadequacy of support and resources to undertake this additional time-consuming responsibility. Ironically, the institutions most in need of additional funding were frequently least able to exploit those sources. With these considerable barriers to grant acquisition, the successful efforts of exemplary leaders were all the more noteworthy. These programs rely on grants as an essential part of their budget resources. In so doing, they have amassed considerable practical experience by which less experienced staff at other sites could potentially profit.

Entrepreneurial Leadership

A significant shared trait among exemplary programs, and yet the most difficult to describe and replicate, is the leadership of people who demonstrated both vision and entrepreneurial drive in establishing and directing these programs. A good leader provides direction and support to staff members, resulting in coordinated efforts towards mutual goals. This trait is evident in the often single-handed leadership and planning role of the founding individual — usually the principal, head librarian, or director. In addition to seeking out industry relationships, these leaders have also displayed personal initiative and resourcefulness by targeting potential granting sources and writing winning proposals to obtain funding. We encountered many such individuals in diverse locations, including the principals at Foshay Learning Center, Northbrook Middle School, and Richgrove School District in central California, and executive directors of the Brooklyn Public Library, and the Puente Learning Center of Los Angeles.

Given the importance of individual leadership, exemplary programs can be dramatically affected by changes in this leadership, such as when a particularly technology-oriented principal is replaced by one who may not place the same value on instructional technology. We encountered several examples of programs that were originally considered model programs, but have since declined with the loss of leadership committed to the presence of technology in the program. The high cost of avoiding obsolescence is possibly a leading reason for this decline, particularly when new leadership is inexperienced or unwilling to seek out creative funding strategies. The ongoing debate over the effectiveness of technology undoubtedly impacts this phenomenon as well.

Community Buy-In

In our experience, strong community participation appears to have a positive effect on the success of information technology programs and some school programs have extensive parent involvement. Parents may visit school campuses for a variety of reasons including the desire to be involved in decision-making on matters that affect their child, visiting the health clinic on campus, and taking advantage of instructional technology components for themselves. Several programs in Los Angeles, Houston, New York City, and Richgrove, California, are actively trying to increase parental presence on school campuses.

A community's confidence in a program's value can provide a ready pool of advocates and providers of financial support, as well as a driving force for implementation. We have seen how the community can become a powerful voice in decision-making discussions on funding at district, state, and federal levels. Although the New Technology High School is not replicable in low-income communities, it is remarkable for the degree of community investment it receives and in its business partnerships.

Collaboration and Information-Sharing

A common problem among many existing information technology programs is that they work in isolation from other programs, unaware of each other. Not only does this limit the exchange of ideas and even resources, but it may also impede the progress of individual students who move from schools with advanced telecommunications to schools with limited telecommunications. Of note, in some urban schools we visited as many as 20-40% of the students are highly mobile. This difficulty, particularly relevant in disadvantaged communities, is one of many barriers to becoming digitally literate for some children. Although this is due in large part to a lack of funding, information sharing can help to alleviate it.

Collaborative efforts depend on administrators knowing about other programs and willingly making the effort needed to coordinate with disparate educational systems. Information sharing eliminates the need to repeat mistakes and maximizes successful practices. Unfortunately, many programs continue to exist in isolation, unaware of what other excellent programs are doing and unable to share their own accomplishments to help others. Ultimately, TRPI's research efforts address this problem, as one means of replicating exemplary information technology programs in underserved communities nationwide.

Developing a technology plan appears to help the process of integrating technology into the curricula and, in fact, most of the more successful programs either have one or are in the process of developing one. For programs that benefit from the E-rate discount, developing a technology plan was a condition of eligibility. A technology plan provides direction and authority to the program and helps consolidate efforts to reach a common goal. Sometimes technology plans are developed by school districts and implemented in all schools within that district, as the Houston Independent School District and Miami-Dade County Public Schools have done. This approach should provide uniformity between program sites and allows for easier and less costly implementation of services. However, many exceptional programs have written their own individual technology plans, frequently reflecting their particular leader's vision, which may be quite ambitious or otherwise express different goals from regional or district efforts. We visited some programs that were far advanced of others and were essentially on independent tracks from regional efforts, although they may be utilizing district resources. Collaborating with other programs would increase their capacity as well as that of others.

Collaboration between schools is a growing phenomenon. Most urban schools are part of "feeder systems" with students from several elementary and middle schools feeding into one high school. When one school in this system has an exceptional telecommunications program, students can be become proficient with the technology and with applying it to their coursework. Thus, schools such as Houston's Davis High School or Foshay Learning Center, take steps to ensure that other schools in their feeder systems coordinate technology programs so their students can go from one grade level to the next without any interruptions in their curricula.

The Question of Efficacy

As the costs of acquiring and maintaining emerging technologies in our learning centers continue to increase, questions about the effectiveness of technology in classroom settings remain. *To what extent does telecommunication-based instruction enhance a child's ability to learn? Are there better ways to spend our educational dollars?* Policymakers and taxpayers rightfully demand to know whether their investment is worth the increased financial burden and that investments are paying off (Trotter, 1998). The rapid pace of technological innovation, and subsequent obsolescence, also means that decision-makers must rule on ever-changing systems and implementation plans.

Critics of technology in education understandably question whether technology has effected measurable achievement (Cuban, 1986; Oppenheimer, 1997; Zeller, 1999). Investment in educational technology represents a sizeable financial, as well as educational, risk since, as Cuban warns, we do not yet know "whether students learn faster and better with computers." There may be more cost-effective methods of producing a learned population of critical thinkers. Current research suggests that the most prudent course may be coordinating education, business, and government agencies in planning and implementing technology in education, thus limiting the risk while maximizing the likely benefits that the technology can offer.

Despite this lack of certainty, the manner in which technology is currently implemented makes intuitive sense, and it becomes a statement about our presumptive belief in its efficacy. Technology is now being used to broaden learning opportunities and to learn basic competency skills such as reading, writing, and math. The goal of digital literacy standards is not to supplant core competencies, but rather to complement the acquisition of traditional competencies — that is, to use resources and process information most efficiently. Computer use in the classroom engages students' interest and appears to increase time on-task, a rough indicator suggesting that students focus on the learning exercise. Certainly the experience of libraries also lends credence to its efficacy and utility in learning environments. This commitment of library resources certainly seems to help them in accomplishing their objectives, reinforcing a role for information technology in learning environments.

The argument in favor of computers in the classrooms is furthered through technology's largely undisputed utility for workforce preparation. High schools have the dual responsibility to prepare students for the workforce as well as for higher

education. This becomes particularly relevant in schools in disadvantaged communities where many students join the workforce immediately after graduation, making access to advanced information technology training for job preparation critical. The New Media Academy at Hollywood High School in Los Angeles, for example, successfully engages at-risk students and keeps them in school in vocational career tracks. Unlike the unskilled, blue-collar careers of the past, these vocational programs can potentially prepare students for better-paying, skilled positions in the entertainment or technical fields.

A continuing concern for this research effort has been how to assess student test score data in evaluating individual information technology programs. Test scores may not necessarily reflect the positive effects that many school officials feel instructional technologies bring about in student performance. Indeed, we have found that few schools demonstrate a direct correlation between improved test scores and the implementation of a technology program. Four out of five roundtable discussion participants grappled with this issue without reaching a consensus on how to manage it. The level of concern, and even frustration, expressed by participants points to the intractability of this issue and to the continuing importance of standardized tests as a measure of student performance.

Are there more cost-effective alternatives to information technology?

Despite the attention this question receives, it cannot be definitively answered. We do know, however, that a larger shift is independently underway in the pedagogy field towards paradigms such as project-based learning which may prove to be quite computer-friendly. This movement may thus ultimately provide the most compelling validation for schools'telecommunication technologies.

Conclusions

Our preliminary findings have the following policy and practical implications that may hasten and stimulate the development of information technology programs in underserved communities:

- *Priority should be given to professional and staff development to ensure that staff feel comfortable with new technology and know how to use it most effectively within the curriculum and for information-seeking strategies. The growing trend toward investing more of the technology budget into training should be encouraged.*

- *Encourage greater communication between programs to share knowledge and experiences and exploit innovative ideas.*

- *Adequate resources also must be made available to staff in schools, libraries, and community centers to enable them to allocate time to write proposals and attend to partnership activities.*

- *Partnerships between learning environments and business and industry will encourage investing in the education of the future workforce.*

The approaching 21st Century is developing as an information-based, global society in which digital literacy will be a prerequisite for full participation. Therefore, anyone not digitally literate will be seriously disadvantaged. Despite these predictions, minority and disadvantaged communities will continue to have insufficient access to advanced technologies. Unequal access to technology and the skills needed to use it means risking isolation of these groups from the larger society's economic, social, educational, and political life.

Manipulating emerging telecommunications proficiently has become an integral component of a comprehensive education. Technology can be regarded as a tool for achieving literacy in a broad sense. Effective reading and comprehension, mathematical thinking, creativity and critical thinking are key components of literacy, regardless of the vehicle.

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